KEA-79 Modeling and Simulation

Who We Were

- Mike Conroy
  - Manager, Constellation, SE&I, SAVIO, Software SIG, Modeling and Simulation Team (MaST)
  - Used to:
    - Lead CxP Data Presentation and Visualization (until Feb, '09)
    - Lead Kennedy Operations Simulation
    - Be part of OCE Engineering Processes Team (ISE)
      - Several other 3 letter words as well
- Rebecca (Bec) Mazzone
  - Manager, Constellation, SE&I, SAVIO, Software SIG, MaST, Data Presentation and Visualization (DPV)
  - Used to:
    - Lead Distributed Observer Network Project within DPV

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Time Plays a Role in System Design

- Apollo First Lunar Launch
  - Mike was there
  - No Bec Yet
- Shuttle STS-1
  - Mike was in college
    - Trying to be a NASA Co Op
  - Still No Bec, Getting Close
- Constellation
  - Mike will be gone before first Moon Launch
  - Bec will retire before Constellation does.

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Constellation Challenges

- CxP was made up of multiple Projects
  - Each made up of more projects, each made up of even more projects down through Level 5
- Those Projects were in various Lifecycle Phases.
  - Some have hardware being built today, some will not produce systems for years
- Those Projects need to be able to work together for at least the next 50 years
  - Many generations of humans, teams, programs, partners & tools
  - Not all alive at the same time

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Common Challenge Area Elements

- ????????
  - **K**nowledge – Decisions, Experiences, Expertise
  - **I**nformation – Reports, Recommendations, Rationale
  - **D**ata – Numbers, Pictures, Models, Equations
- Knowledge is really hard
  - It is in peoples heads; they are attached to them
- Information is somewhere in the middle
  - It requires data, but also a lot of other stuff
- Data is fairly easy
  - Just record it; lots and lots of disks
  - Finding it later is another matter, possibly for another generation

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Where to Start

- Understand the KID
  - What does it look like
  - Where does it live
- How Does it Act
  - How do they play with each other
  - How do we make it easier for a new KID to play too
- How do we Protect It
  - How do we protect them from each other (IP Issues)
  - How do we best preserve them for the future

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MaST Approach

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MaST View of Knowledge

- It is created through experiences
  - What did they look at? How did they use it?
  - Who was involved? What did they learn?
  - What did they know when they started?
  - What tools did they use? When? Which Versions? What Inputs?
- It lives in the people involved in the experience
  - The test team, the analysis team, the decision makers
- It is by far the hardest component to manage
  - It is very often based on "Being There"
  - Everyone cannot "Be There"

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MaST View on Information

- It is distilled from the data provided by the tools.
  - Analysis Results
  - Recommendations
  - Supporting Rationale
  - Risk Assessments
- It lives in the documentation provided by the process and the associated CM systems
  - Test Results, Test Reports, Presentations
  - These tools have demonstrated their ability to publish their information for use by others

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MaST View on Data

- It comes from the analysis tools being used across Constellation
  - Pro-E for the flight vehicles
  - Arena and Extend for the integrated supply chains
  - Delmia for the integrated process analysis
  - IMSim (Trick Based) for integrated flight simulations
  - ScramNET for Launch Vehicle dynamics
- It lives in these tools, files and CM systems
  - DDMS(s), Common Model Library(s), WIKI(s)
  - These tools have demonstrated they can publish data for use in other systems
  - Note – This is usually where Intellectual Property (IP) issues show up

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Where MaST found the K, I and D

- Look at a sample of Constellation Tools
  - Find where each is stored
  - Map how they flow through the system
  - Identify how to get them out
  - Normalize so others can see if their K, I or D can play
- We noticed some tool/location groupings
  - Some live in Physics Based Tools
    - System State Information, Structural Information
  - Some live in Physical Environment Tools
    - Temporal / Spatial Information
  - Some live in Supply Chain Tools
    - What you need when you need it (that is a different KEA)

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Physics - System State Information

- Primarily related to the Flight activities
  - Launch Preparations, Flight and Post Flight
  - Start with Guidance, Navigation and Control
  - Extend to Flight Dynamics as needed
  - Extend wherever else is needed.
- Physics Based Motion, Accompanied by Necessary Graphical Elements.
  - Physics Based Launch, Ascent, Dock, Entry, Descent, Landing, Recovery, Retrieval
  - Couple with High Resolution Graphics For Human in the Loop Test and Evaluation

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For the Physics Example (VM #1)

- Take Ares, Orion, Ground Ops, LAS and ISS
  - Teach the Projects to talk to one another
    - MAVERIC and ANTARES on Flight Side
    - Ground Operations Simulation
    - LAS Simulation and ISS Simulation
  - Provide infrastructure to let People and Simulations talk to one another
    - High Level Architecture, Trick, DS Net, DON
  - Provide the ability to share the new K, I and D created with existing and future generations

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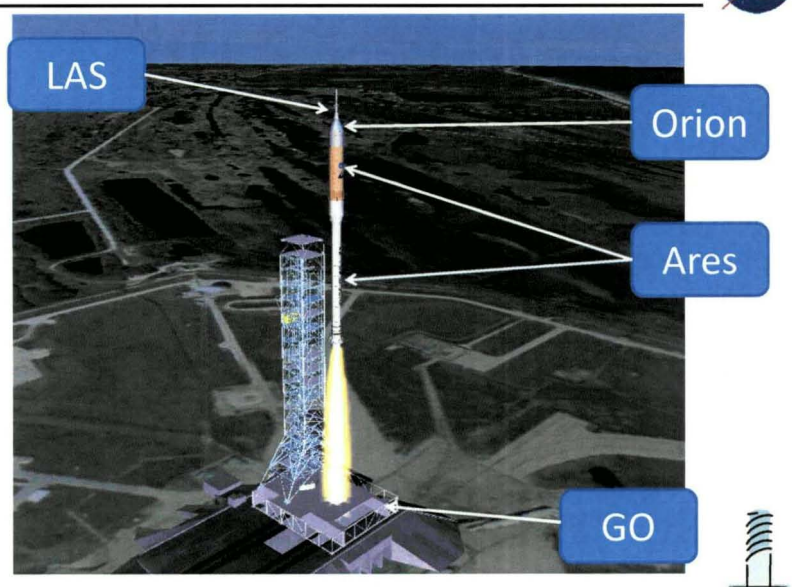
Ares 1 Launch (IMSim), VM #1



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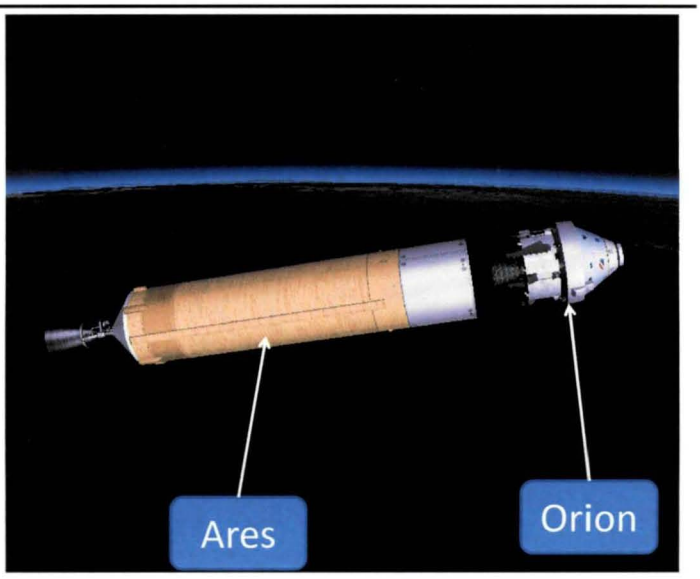
US and Orion Stage Separation (IMSim)



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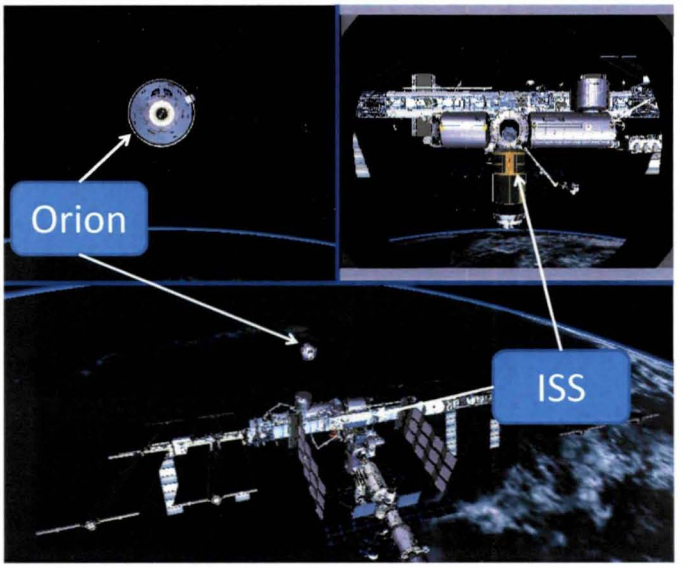
Orion to ISS Docking (IMSim)



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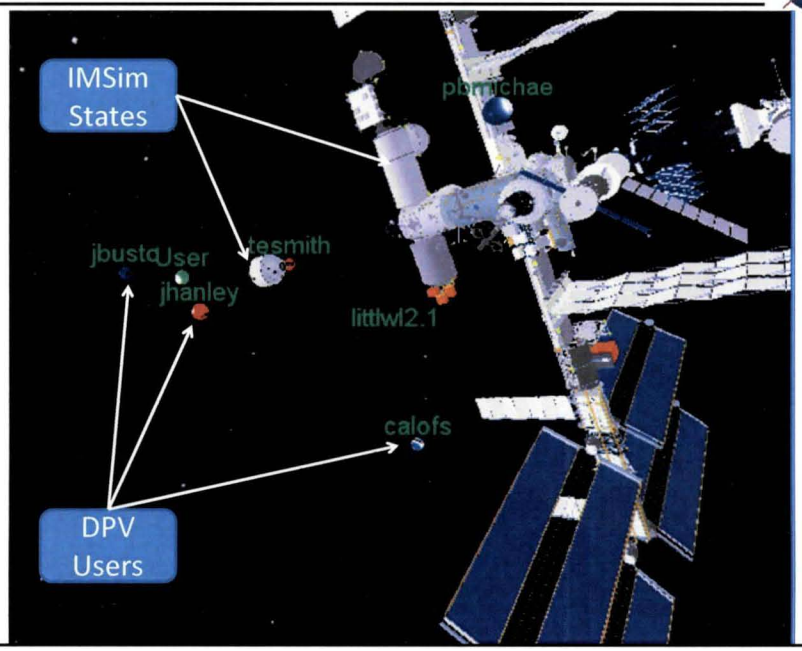
Distributed Review and Storage (DPV)



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This Enables a LOT!

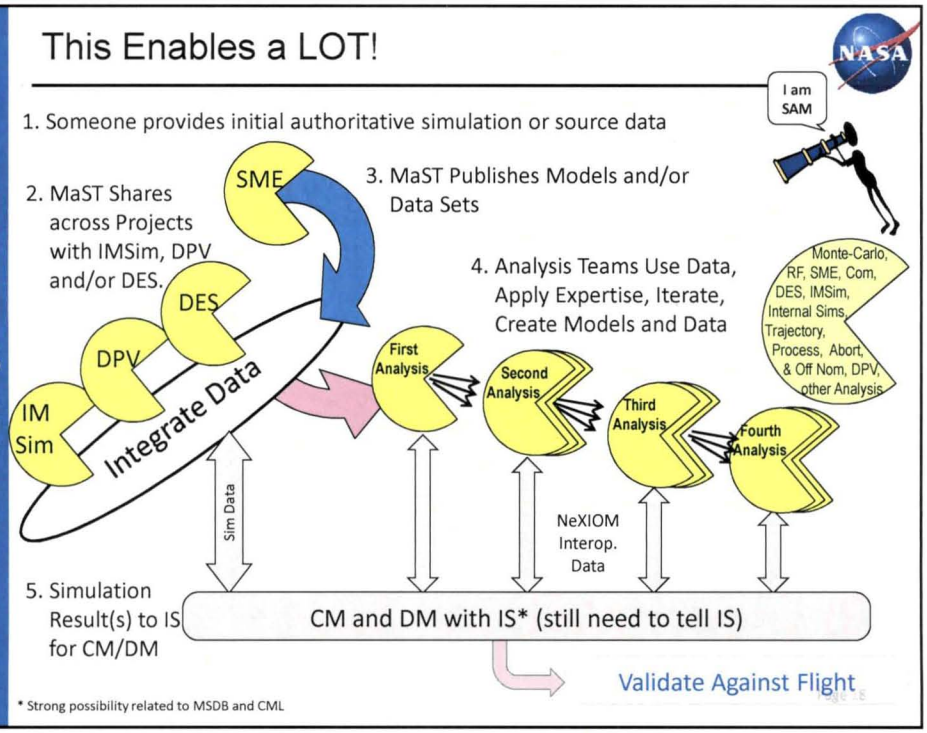
1. Someone provides initial authoritative simulation or source data

2. MaST Shares across Projects with IMSim, DPV and/or DES.

3. MaST Publishes Models and/or Data Sets

4. Analysis Teams Use Data, Apply Expertise, Iterate, Create Models and Data

5. Simulation Result(s) to IS for CM/DM



* Strong possibility related to MSDB and CML

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Preserve K, I, and D for the Future

- Standard IS and ICE Systems
  - Getting more and more services every day
  - Well tuned for Data and Information
  - Knowledge is different it is experience based
- On the Knowledge Side, you need to be able to re-experience the learning process
  - Since most of what we are doing today is simulation, means you need to re-experience the simulations that helped develop the Knowledge
  - This is very difficult when the simulation computers, software, people and systems are gone
  - But, if I can save the Simulation……

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Save the Simulation

- This is a Key Mission for the MaST Data Presentation and Visualization (DPV) Element
  - Simulator provides a description of the 4-D data that represents the simulation used to make decisions.
  - The Simulator can also provide key measurements and images for display.
  - It will soon be able to provide relevant Meta-Data
- The Simulation can then be replayed for team analysis or long term storage
  - Without need for the simulation infrastructure.
  - Goal is to be able to do this forever
  - We have already started

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So, what are we really talking about. Why does Kennedy care?

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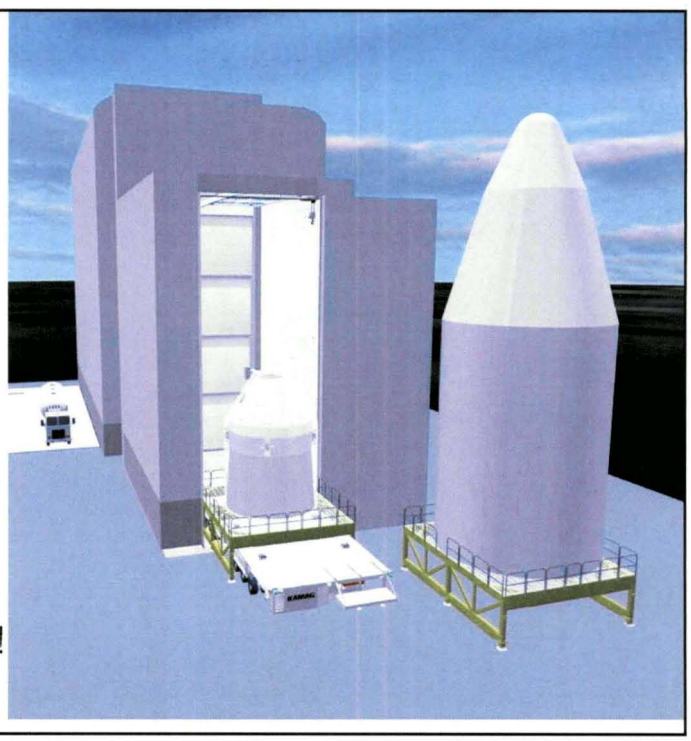
PHSF

Um,
It will NOT fit!



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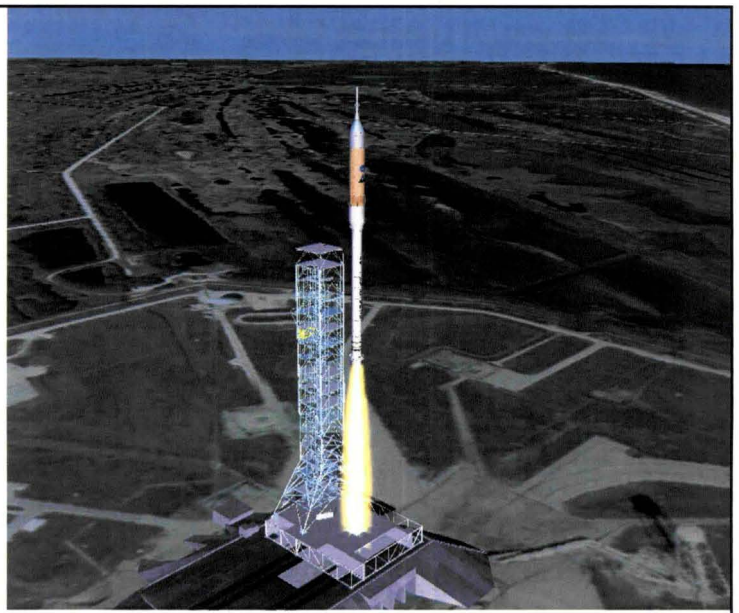

Um,

Remember Those Bolts

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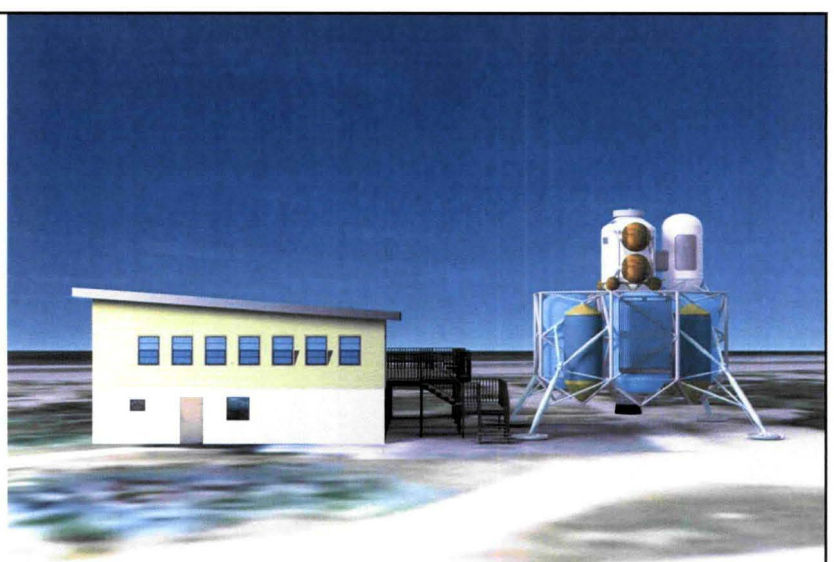

Yes,

It really is that big!

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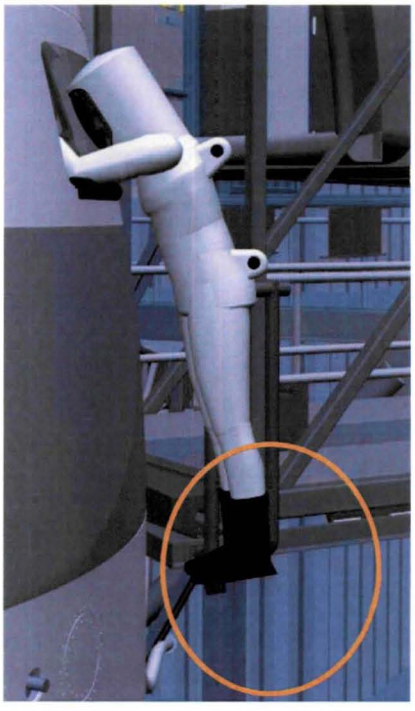
I Can Fly



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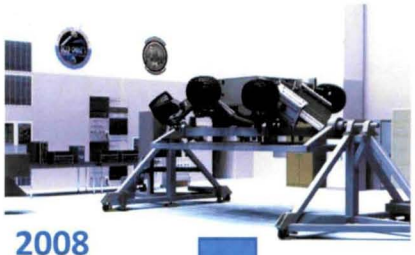
Mars Science Lander

2008



2008

2011

2011

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HDU
Habitat Demonstration Unit

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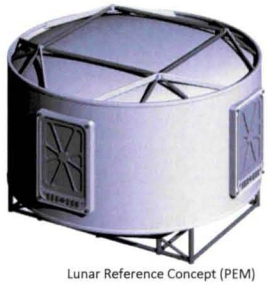
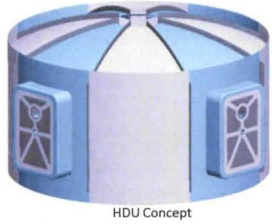
HDU Overview

- Vision
  - Develop, integrate, test, and evaluate a LSS Habitat Demonstration Unit (HDU) that will be utilized to advance NASA's understanding of alterative mission architectures, requirements definition and validation, and operations concepts definition and validation.
- Timeline
  - Project Kick-off: June 2009
  - Shell Manufacturing: October 2009 – April 2010
  - Systems Integration: April – August 2010
  - Desert RATS September 2010
- Participation
  - Jointly managed across JSC, KSC & JPL
  - Shell Construction at LaRC
  - Assembly and Integration at JSC
  - Subsystems from ARC, GRC, JPL, JSC, KSC, LaRC, MSFC



Lunar Reference Concept (PEM)



HDU Concept

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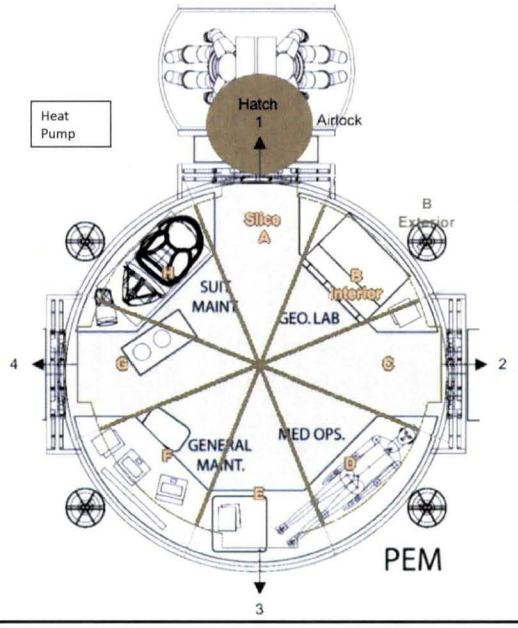
Notional Interior



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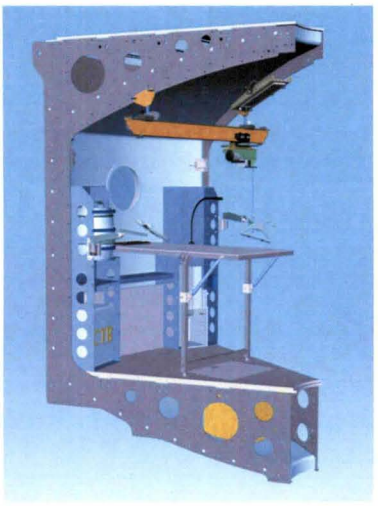
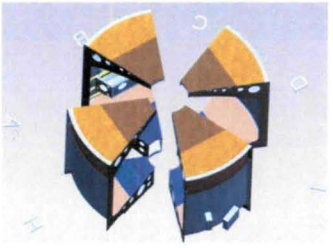
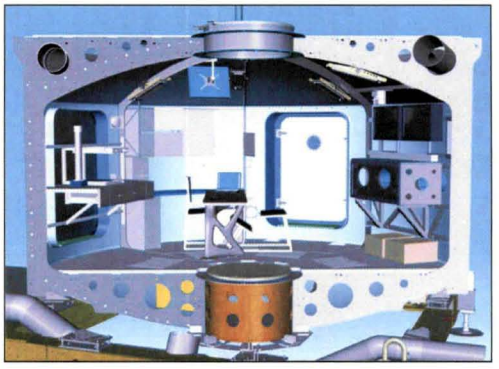
Virtual Integration - Interior







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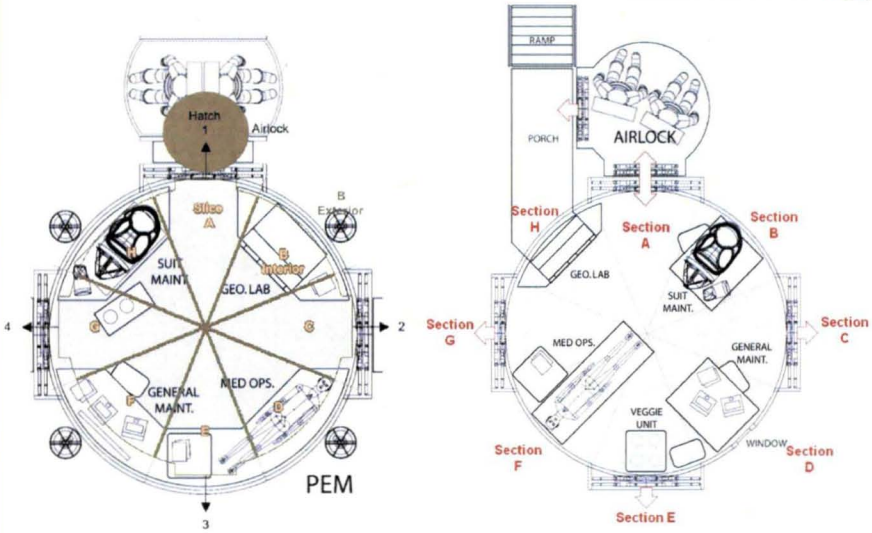
Interior Evolution



October 2009 July 2010

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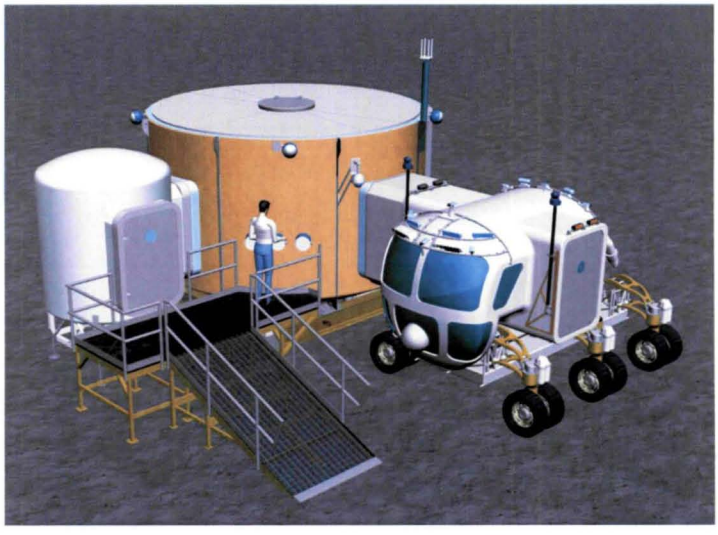
Virtual Integration - Exterior



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Concept Realization

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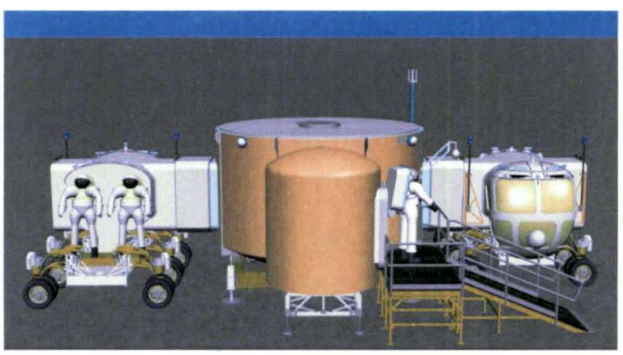

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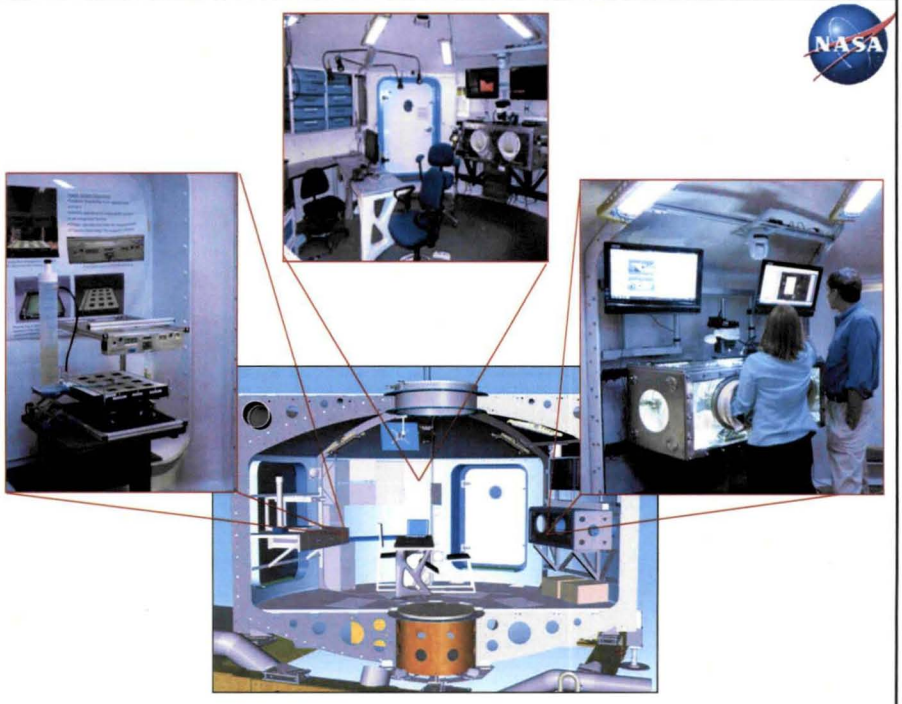

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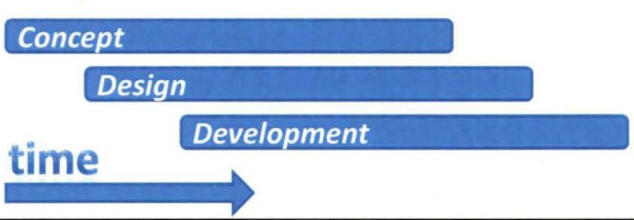
Concurrent Design

- HDU CAD integration rapidly grew to system simulation, then concurrent development
  - Concepts were matured in design sessions
    - Concept developed, "model" updated, package base lined
    - Design completed, "model" updated, build
    - Multiple Centers, Teams, Projects, Time Zones and Budgets
- Not just because of Simulation
  - HDU leadership broke down the decisions such that critical elements were decided on first
    - Even if only allocations
  - Sim did communicate and document those decisions



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So, Where are We Going?

NASA Flexible Path

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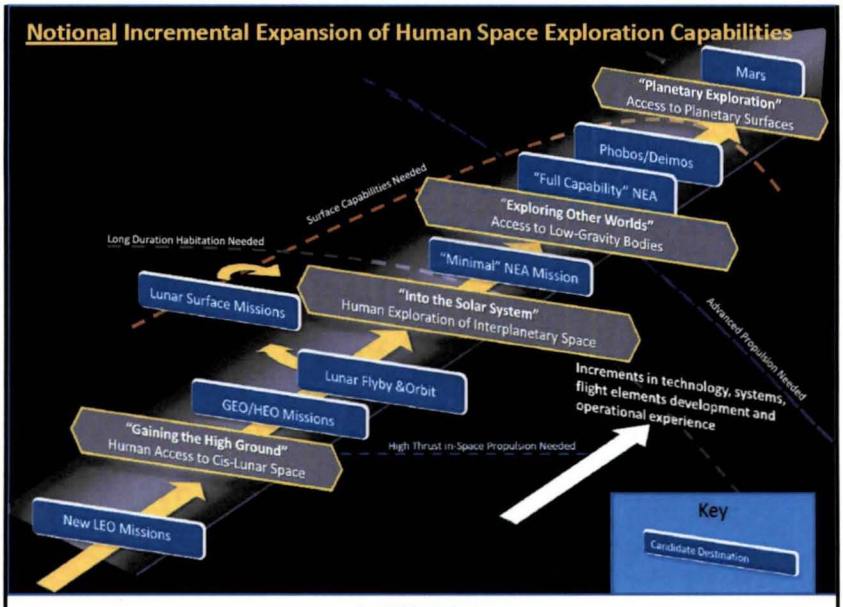
From ESMD, now HEO



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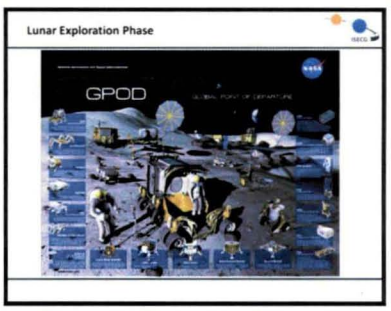
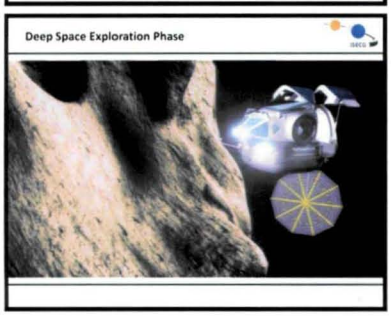
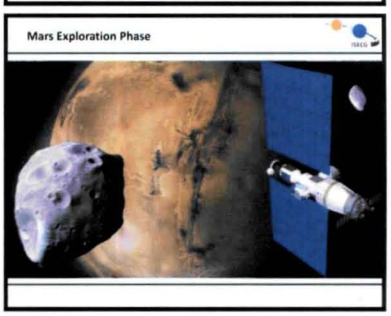
The Current Phases







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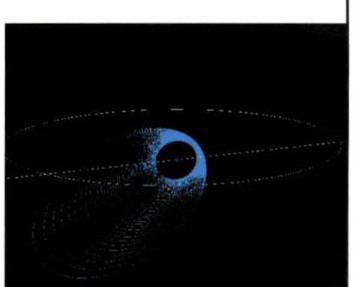
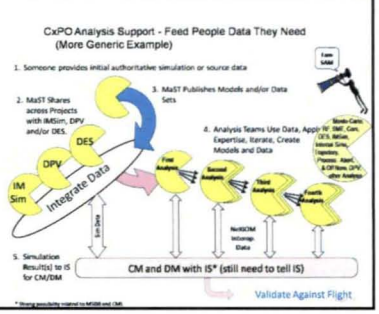
So, For Example, Today….

- We have a:
  - For a 2 year mission to HEO, as with SEP, you get a lot of data
  - That needs to be saved, then analysis run on that data, that data saved, and analysis run repeat, repeat, repeat
  - We have EVE, a tool with development led at Kennedy
  - We have PacMan, gaining acceptance at a scary rate
  - We have Analogs, where we verify the performance of systems
  - And, we save enough K, I & D that future generations can complete the mission





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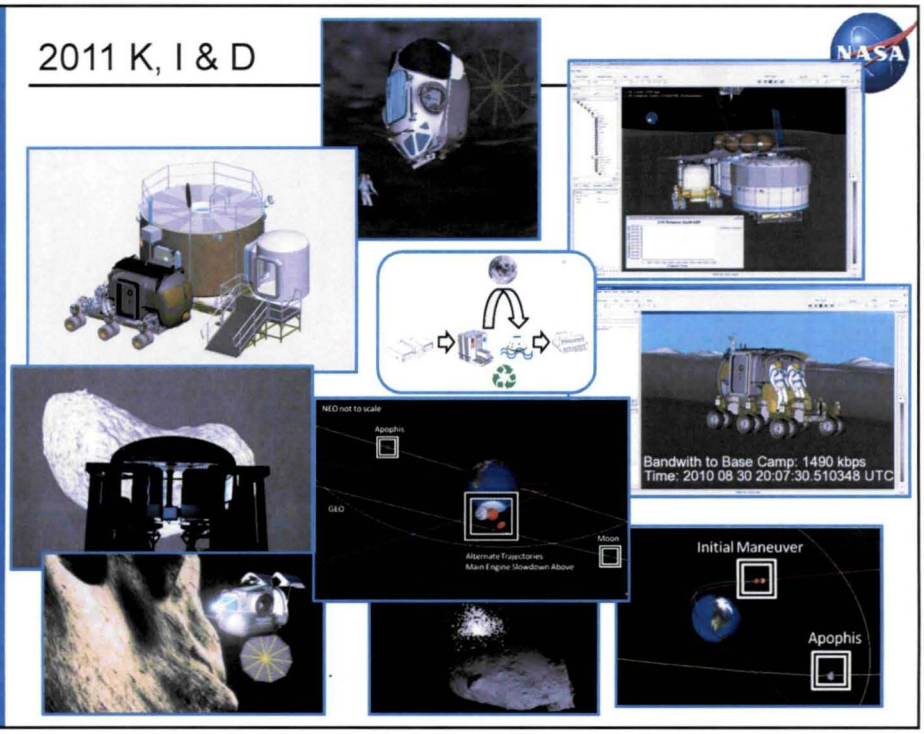
2011 K, I & D



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We need to add the "S"

- **K**nowledge – Decisions, Experiences, Expertise
- **I**nformation – Reports, Recommendations, Rationale
- **D**ata – Numbers, Pictures, Models, Equations
- **S**imulations – Fusion of Data, Information & Knowledge
- So Really, it is all about taking care of our KIDS